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I) INTRODUCTION

Accounting theoreticians have long debated the merits of alternative concepts of earnings as surrogates for economic (or Hicksian) income.[1] These ideological confrontations, yet unresolved, have arisen again in the recently published Trueblood Report entitled "The Objectives of Financial Statements."[2] In an attempt to provide a quantitative basis for resolving these issues this study seeks to evaluate several methods of earnings measurement vis a vis an economic income standard -- i.e., the "permanent earnings" of the firm.[3]

The basic approach utilized to develop these accounting surrogates of economic income is simulation. Besides the frequently cited generic advantages of simulation (e.g., manipulation of variables and parameters, ability to consider alternative policies, no disturbance to actual system, etc.) several specific advantages intrinsic to this research study may be identified. First and foremost is the existence of the requisite data base to evaluate the alternative accounting earnings methods. While McKeown and Revsine have recently demonstrated the feasibility of implementing net realizable value and replacement cost accounting, no "real world" data base yet exists to empirically evaluate such alternatives longitudinally over time for a large sample of firms.[4] Second, and apart from the question of purchasing power gains or losses, the economic income of a firm cannot be measured prior to actual liquidation. Hence, even the availability of a "real world" data base would not suffice barring a situation which runs counter to the "going concern" concept. Finally, simulation permits the same set of economic events to be measured through several different filters (e.g., historical cost, replacement cost and net realizable value)

without incurring the transaction costs of multiple data transformations that would be found in a "real world" setting.

Having necessarily opted for a simulation approach this study has extended an earlier work by Greenball.[5] While the fundamental model employed is similar to Greenball's, significant modifications have been incorporated in order to amplify, and more importantly, expand the scope of his research. Accordingly, given the importance of these variations each will be discussed in turn.

II) EXTENTIONS FROM GREENBALL"S STUDY

A) Net Realizable Value

Greenball's paper essentially compared historical cost and replacement cost earnings (absorption and direct measures of each) versus a permanent earnings concept.[6] Specifically, a series of pairwise comparisons was made between the sample means of six performance index values (relating to earnings and rate of return) in order to test for equivalence of such means utilizing t-ratios of the difference statistics.[7]

This study, in addition to replicating Greenball's comparisons, has included the net realizable value method of earning measurement in the simulation model. Net realizable value of an asset is defined as the maximum net amount which can be realized from the disposal of that asset within a short period of time (not a forced sale situation, but not long enough to allow disposal of fixed assets through ordinary use of services.) Income, under this valuation scheme, is the excess of realized revenues over expired disposition values of assets at the time of their severance.[8] Specifically, two measures of net realizable value earnings were utilized and will be described at a later point.

B) Input Price Changes

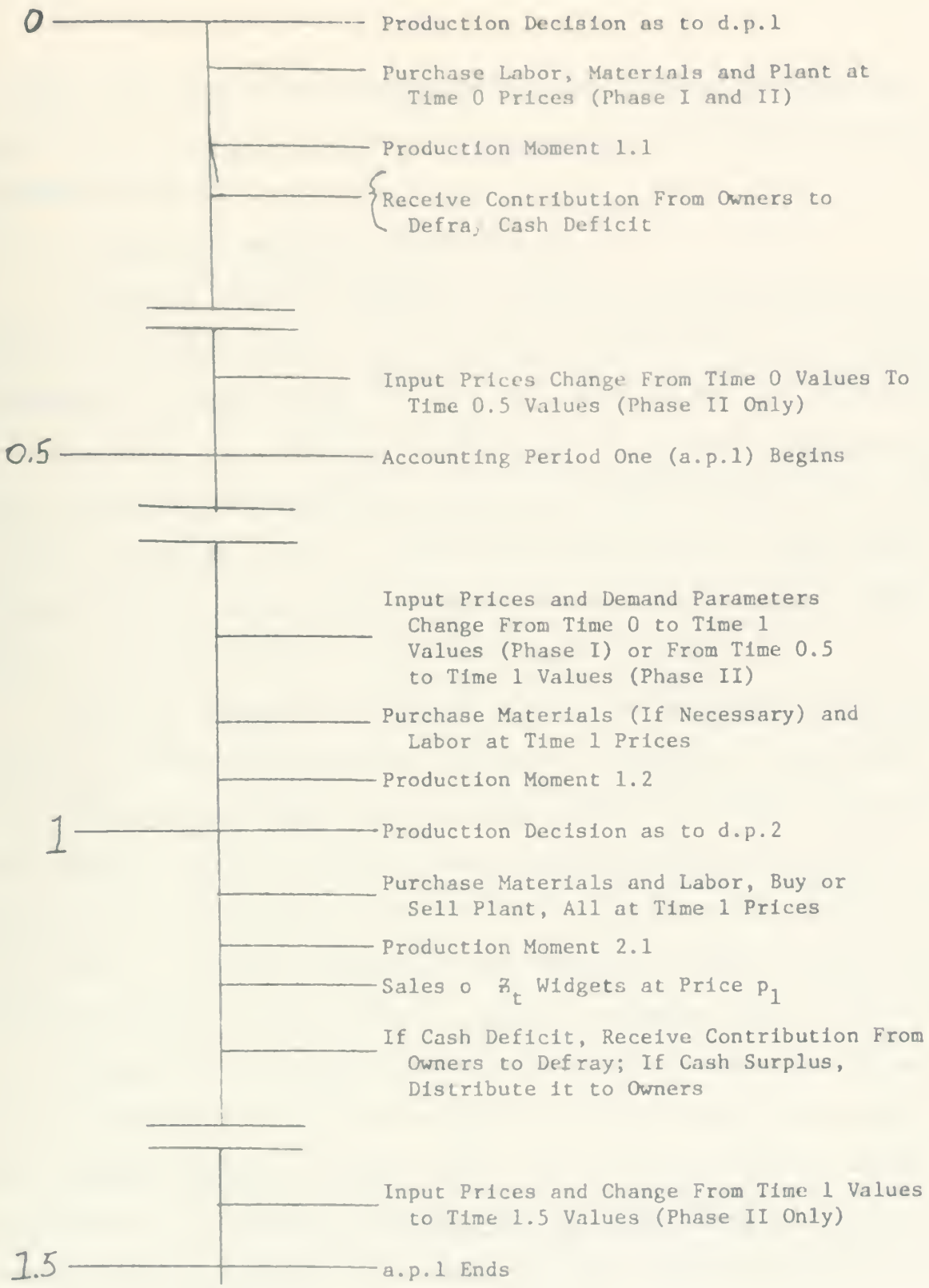
The simulation model developed by Greenball employed three inputs to the production process--labor, material and physical plant. The simulated firms

had available the current price of each input prior to their decision regarding production for the current period. These current prices plus estimated future prices and demand were used to determine the production levels the firms would operate at during the next period. His model was designed to allow price changes of such inputs only once during a given "decision period"--following the beginning of the accounting period but preceding the second production moment. (A decision period is equivalent in length to an accounting period, though one accounting period ends at exactly the mid-point of a decision period and a second accounting period begins--see Figure One for a graphical presentation).

This study, in addition to replicating the time sequence of price changes as defined by Greenball (hereafter referred to as "Phase I"), modified the basic model such that price changes occurred twice during a given decision period. This modification is referred to as "Phase II." The first price change occurred, as before, following the beginning of the accounting period but preceding the second production moment. The second price change occurred after the production decision but immediately prior to the end of the accounting period. (These relationships are also depicted in Figure One.) Accordingly, this second price change impacts upon inventory valuation and hence reported earnings. Through utilization of the simulation model the results of this phase were then compared to findings of Phase I.

The justification of this modification is based in the simulation process itself. That is, simulation is an attempt to model a "real world" system. As such, Greenball's assumption of price changes occuring only before a production decision and the second production moment was thought to be rather limiting. By allowing a second change to occur after the production decision but before the end of the accounting period it was felt the Phase II results would better mirror

FIGURE ONE


0
Production Decision as to d.p.1
Purchase Labor, Materials and Plant at Time 0 Prices (Phase I and II)
Production Moment 1.1
Receive Contribution From Owners to Defray Cash Deficit
Input Prices Change From Time 0 Values To Time 0.5 Values (Phase II Only)
0.5
Accounting Period One (a.p.1) Begins
Input Prices and Demand Parameters Change From Time 0 to Time 1 Values (Phase I) or From Time 0.5 to Time 1 Values (Phase II)
Purchase Materials (If Necessary) and Labor at Time 1 Prices
Production Moment 1.2
1
Production Decision as to d.p.2
Purchase Materials and Labor, Buy or Sell Plant, All at Time 1 Prices
Production Moment 2.1
Sales o $\bar{x}_t$ Widgets at Price p_1
If Cash Deficit, Receive Contribution From Owners to Defray; If Cash Surplus, Distribute it to Owners
Input Prices and Change From Time 1 Values to Time 1.5 Values (Phase II Only)
1.5
a.p.1 Ends

reality. As a result, any conclusions drawn from the paired comparisons would not be restricted to the rather hypothetical environment depicted in Greenball's model.[9]

C) Predicted Earnings and Rate of Return

An implicit unstated assumption of Greenball's study is that users of financial information desire an accounting earnings figure to be a perfect estimator of economic income.[10],[11] In fact, most (if not all) users would be satisfied with an accounting earnings figure which, when filtered through some transformation process, would produce the economic income for the time period in question. That is, users would be satisfied if a transformation function (f) exists which maps accounting income (x) into economic income (y); or $y = f(x)$, for all x and y when a known f exists.

With this viewpoint as a foundation this study attempted to determine if such a transformation function does exist. Specifically, taking each accounting and the permanent income figures generated in Phase I and II of the simulation model, a multiple linear regression model was utilized to determine if a transformation function could be found (hereafter referred to as Stage I). A similar analysis was also employed to find a transformation function relating accounting rate of return to permanent rate of return (PROR).

Having derived the necessary parameters a second computer run (Stage II) of the simulated firms was made in which accounting earnings were transformed into predicted permanent earnings ($\widehat{PE}_{ijt}$) and accounting rates of return were transformed into predicted permanent rates of return ($\widehat{PROR}_{ij}$). These predicted values were then compared to the actual permanent earnings and rate of return to determine the feasibility of developing such transformation functions. That is, are the transformed accounting earnings and rate of return significantly

better predictions of actual permanent income and rate of return than the "raw" accounting earnings? A complete discussion of the methodology and the results will be offered in a later section of this paper.

III) OVERVIEW OF SIMULATION MODEL

In order to provide a description of the concepts and attributes embedded with the simulation model, a brief overview of its features will be outlined.

A) The Permanent Earnings Concept

Given this study's objective of evaluating alternative methods of earnings measurement vis a vis economic income, a concept of economic income must first be postulated and then operationalized in order to perform such evaluations. The one employed within this study is the "permanent earnings concept" as defined by Greenball. Rather than simply redefining the underlying axioms which uniquely define this concept the reader is referred to Greenball's study for a complete derivation of the permanent earnings concept and the justification for its use.[12]

B) Model of Simulated Firms

Needless to say a simulation of any process represents a complex computer program. Hence, this discussion will be restricted to solely a review of the fundamental features of the simulated firms. Since the basic model employed within this study is founded upon Greenball's work much of the following discussion will parallel his description.[13]

1) The Firms

Each simulation run of this study encompassed 200 firms homogeneous with respect to product and requisite inputs but representing a hetrogeneous grouping of variable attributes which affected actual performance. While these variable attributes will be described in a later section, suffice it to say such attributes allow the results of this study to be generalized over a large class of firms.

Each firm j began operations at time period zero (t=o) and was permitted to liquidate at any point in time (T_j) with the singular constraint all firms must be liquidated no later than at the end of period 60 ($T_j \leq 60$).[14] This forced liquidation feature was necessary to allow calculation of the permanent earnings (PE_j) for each firm j.

In the model two separate time horizons were employed--a "decision period" and an "accounting period." Decision period 1 (d.p.1) begins at time 0 and ends at time 1. The production decision is made instantaneously at the beginning of the decision period and this decision holds throughout that decision period. An accounting period (a.p.) begins exactly at the midpoint of one decision period and ends exactly at the midpoint of the next decision period. Hence, each accounting period is exactly equal in length to a decision period. Thus for a given firm j it has $T_j - 1$ accounting periods. That is, neither the first half of the first decision period nor the last half of the last decision period are included in the respective accounting periods. (These time relationships are depicted in Figure One.)

This overlap of accounting periods upon decision periods is crucial to the simulation model. By straddling the decision period each firm is assured of maintaining a finished goods inventory (and possibly a raw materials inventory) at the beginning and end of each accounting period. This feature impacts upon the different methods of accounting earnings measurement in that both physical plant and inventory must be valued under alternative valuation schemes.

A final attribute of the accounting process relates to the transactions in which each firm engages. As a simplifying assumption all transactions are solely for cash. Further, cash flows occur between the firm and its owners in such a manner that cash balances (be they positive or negative) are held for

no longer than an instant of time. Such flows take several forms: (1) a series of flows from a firm to its owners, (D_t), which is composed of dividends or cash payments for shares reacquired by the firm, and (2) a series of flows from the owners to the firm, (F_t), which represents gross cash proceeds from a primary issuance of shares.[15]

2) The Product

Again as a simplifying assumption all firms have but a single product--a "widget." The price received by each firm is determined from a market demand function which can be expressed as follows:

Let: t = time period

p = selling price

α = intercept parameter

β = slope parameter

z = quantity sold

Then: $p_t = \alpha_t + \beta_t \cdot z_t$ For $\alpha_t > 0$ and $\beta_t < 0$ (1)

The actual derivation of this relationship is a stochastic feature of the model and will be developed at a later point of this paper.

3) Production

The production of one widget requires direct input of one unit of raw material and one unit of labor where prices during time period t are given by the sequences p_t^m and p_t^l respectively. Similarly, to produce z_t widgets the firm must have n_t units of plant capacity (where $n_t > z_t$) available immediately <u>following</u> the production decision.[16] The price of a single unit of plant input $(n = 1)$ for period t is given by the sequence p_t^f. When a firm decides to dispose of a portion of its plant capacity it receives p_t^d per unit, where p_t^d is a prespecified fraction $\mathcal{V}$ (where $\mathcal{V} < 1$) of the prevailing price--i.e., $p_t^d = \mathcal{V} \cdot p_t^f$. Further, plant depreciates at a predetermined rate of δ per decision period

such that at the end of d.p.t. there remains $(1 - \delta)n_t$ units of plant capacity.

In the model production takes place twice during a decision period. Production moment one (p.m.t_1) occurs immediately following the beginning of each decision period, d.p.t., while production moment two (p.m.t_2) takes place immediately before the end of that decision period. Once a firm has decided the quantity of widgets it will sell (z_t) it must manufacture one half of that quantity ($\frac{z_t}{2}$) at p.m.t_1 amd an equal quantity at p.m.t_2.

While the firm has no choice as to its production level (once z is determined), it does have two options with respect to raw material purchases. It can purchase and inventory z_t units of raw material immediately preceding p.m.t_1; alternatively, it can acquire $z_t/2$ units immediately before p.m.t_1, and a like quantity before p.m.t_2. This choice is a result of expected input prices at d.p.t. vis a vis the known prices at d.p.t-1. This decision process is described in a later section of this paper.

4) Model Paramaters

a) Constant Parameters

As stated earlier the simulation process encompassed 200 firms. Embedded within the model are several parameters which are constant across all such firms. These value are summarized in Table 1.

Symbol	Parameter	Value
T	Maximum life of firm (in d.p.'s)	60
δ	Interest rate used in decision-making	.06
γ	Ratio of plant selling price to plant buying price . .	.85
	Standard deviation of relative change in demand parameter	.01

TABLE 1

Constant Parameters

b) Stochastic Features and Parameters

While each of the 200 firms simulated utilized the same inputs and produced the same product, several stochastic features were built into the model in order to generalize the results of this study. For each firm the value of each of the stochastic attributes was chosen at random from a population of values uniformly distributed over a specified range. These values were selected at t=0 and the demand function parameters and input prices were then adjusted in such a manner as to generate an expected rate of return for accounting period one ($a.p._1$) of 20%. These stochastic parameters primarily relate to the price of inputs and the α intercept of the demand function. The parameters and their ranges are summarized in Table 2.[17]

Mnemonic	Parameter	Range
DEPR	Depreciation rate per period (S)	.125 to .250
GROW	Systematic growth rate (g)	.0 to .1
FRST	Ability to forecast next period changes in stochastic parameters	none to perfect
CVAR	Standard deviation of relative change in input prices	.02 to .06
ALCR	Correlation coefficient between relative change in demand parameter and relative changes in input prices	.0 to .5

TABLE 2

Variable Parameters

5) Decision Making

At the beginning of each decision period each firm must determine the following: (1) z_t - sales for d.p.t., (2) n_t - plant capacity for d.p.t. and (3) raw material purchase option--either (a) z_t units of raw material before $p.m.t_1$ or (b) $z_t/2$ units before $p.m.t_1$ and $p.m.t_2$. Each firm selects

these quantities by maximizing the expected value criterion:

$$C_{t-1}(t) + (\bar{C}_t(t) + \bar{V}_t) / (1 + \rho) \qquad (2)$$

where:

$C_{t-1}(t)$ is the net cash flow associated with: (1) the purchase of either: (a) z_t units of raw material or (b) $z_t/2$ units of raw material, (2) the purchase of $z_t/2$ units of labor, and (3) the purchase or disposal of plant--where all events occur just prior to production moment t_1.

$\bar{C}_t(t)$ is the expected net cash flow associated with: (1) the purchase of $z_t/2$ units of raw material--if purchase option 1b (from above) is selected, (2) the purchase of $z_t/2$ units of labor, and (3) the sale of z_t widgets at the expected price of $\bar{p}_t$.

$\bar{V}_t$ is the expected liquidation value of the firm at the end of d.p.t.. Since: (1) no inventory is maintained at the end of d.p.t.--and (2) no receivables, payables or retained earnings are maintained--i.e., all transactions are for cash, then $\bar{V}_t$ represents the expected liquidation value of the plant at the end of d.p.t. Symbolically,

$$\bar{V}_t = \bar{p}_t^{\,d} \cdot n_t (1 - \delta)$$

where: $\bar{p}_t^{\,d} = \nu \cdot \bar{p}_t^{\,f}$

ρ is the interest rate used by the firm for decision making purposes.

Given the uncertain nature of the stochastic parameters found in the time t values each firm employs the expected values of these parameters as certainty equivalents for the true values in order to derive a solution to equation 2. The expected values utilized by each firm are dependent upon: (1) the firm's forecasting ability with respect to parameter changes--i.e. see this discussion of "FIRST" in Appendix 1 and (2) the parameter values at the beginning of d.p.t. which are known to the firm.[18]

IV) ACCOUNTING METHODS EVALUATED

In this study eight accounting methods were evaluated, $i = 1,2,\ldots,8$:

i	Symbol
1	HA
2	HD
3	BA
4	BD
5	CA
6	CD
7	N
8	N+

where H represents historical cost, B is business profit, C is current operating profit, N is net realizable value (unadjusted), N+ is net realizable value adjusted for the excess of cost over net realizable value (at time of purchase) of any new plant purchased during the period, A is absorption costing for the widgets inventory, and D is direct costing.

For each method a measure of capital (K_i) at the end of the accounting period (a) was determined as follows:

$$K_{a,i} = M_{a,i} + W_{a,i} + F_{a,i} \qquad (3)$$

where: M is the book value of raw materials inventory. (note: a raw materials inventory will exist only if the first purchase option is selected—i.e., Z_t units purchased at the beginning of d.p.t.)

W is the book-value of completed widgets.

F is the book-value of plant.

Historical cost capital (methods 1 and 2) was determined by valuing F at historical cost while M and W were valued at moving average historical cost.

Business profit capital (methods 3 and 4) and current operating profit capital (methods 5 and 6) were determined by valuing M, W and F in terms of the replacement (entry) prices for raw materials, labor, and plant as of the valuation date. Finally, net realizable value capital (methods 7 and 8) was found by valuing M, W and F in terms of the disposal (exit value) prices as of the valuation date.

Similarly, for each method accounting period a's earnings ($P_{a,i}$) were measured. For methods 1 through 4 and 7 this process can be summarized as follows:

$$P_{a,i} = K_{a,i} - K_{a-1,i} + C(a) \quad \text{for: } i=1,\ldots 4 \text{ and } 7 \tag{4}$$

where: C(a) is the net cash flow from the firm to its owners during a.p.a.--i.e., C(a) = D(a) - F(a)

Since the current operating profit methods differ from the business profit methods by excluding holding gains (or losses) the earnings expressions for methods 5 and 6 may be stated as follows:

$$P_{a,5} = P_{a,3} - ({}^{a}K_{a-1,3} - K_{a-1,3}) \tag{5}$$

$$P_{a,6} = P_{a,4} - ({}^{a}K_{a-1,4} - K_{a-1,4}) \tag{6}$$

where the quantities $({}^{a}K_{a-1,3} - K_{a-1,3})$ and $({}^{a}K_{a-1,4} - K_{a-1,4})$ represent the holding gains (or losses) during accounting period a. That is ${}^{a}K_{a-1,3}$ and ${}^{a}K_{a-1,4}$ represent the capital of the "a-1" asset groupings valued at time "a" prices. Finally, the adjusted net realizable value earnings (method 8) were calculated as follows:

$$P_{a,8} = P_{a,7} + (acq)\ (p^{f}_{a-\frac{1}{2}} - p^{d}_{a-\frac{1}{2}}) \tag{7}$$

where: "acq" represents the units of plant acquired during a.p.a.

The absorption costing (A) earnings measurement (methods 1, 3, and 5) differ from their direct costing (D) counterparts (methods 2,4,6) only with respect to

the valuation of the widgets inventory. While all methods include material and labor components in the valuation of W, the absorption methods also included a fixed overhead component. Given the structure of the simulated firms the only fixed overhead component is depreciation. For the absorption methods the overhead charge per unit was determined by taking the ratio of depreciation in the accounting period in which the widget is manufactured to the normal production volume in that period where the latter is a weighted average of past period production volume.

A final evaluation of the eight accounting methods was with respect to rate of return. For each method i period rate of return ($r_{a,i}$) is basically determined by finding the ratio of earnings ($P_{t,a}$) to the average capital in the accounting period--i.e., $(K_{a,i} + K_{a-1,i})/2$.[19]

V) ALTERNATIVE STATES SIMULATED

This study utilized the basic simulation model, previously described, to test four different situations. The modifications to the model and rationale for testing each state will be discussed in turn.

A) Phase I - Stage I

The first state tested was primarily a replication of Greenball's study. The simulation model utilized (a detail description was provided in Section III) is best characterized by two attributes. First, price changes for inputs occurred only once during a given decision period--immediately preceding the second production moment ($p.m.t._2$). Second, "raw" accounting earnings (for each of the eight methods) were compared to permanent earnings--i.e., no transformations occurred.

B) Phase I - Stage II

This stage had the objective of determining whether a transformation function could be found which, after processing the raw accounting data, would statistically

provide better estimates of permanent earnings than the raw data. The procedure which was utilized is analogous to a user employing historical accounting information, for a given firm or set of firms, to derive a set of estimated functions which transforms accounting earnings (however defined) into predicted values of economic income and accounting rates of return into predicted values of economic rate of return. Again input prices were changed only once during each decision period--before the second production moment.

The actual methodology to derive such a function required a multi-step procedure.

Step 1 Upon completion of Phase I Stage I - eight accounting earnings streams for each of the two hundred firms had been generated.[20] Similarly, the permanent earnings streams for each firm had also been determined.[21] At this point a series of 1600 linear regressions were run to determine α and β coefficients as follows:

$$PE_{j,a} = \alpha_{i,j} + \beta_{i,j} \cdot P_{i,j,a} + e_{i,j,a} \qquad \begin{array}{l} \text{For: } i = 1,8 \\ \quad\; j = 1,200 \\ \quad\; a = 1,59 \end{array} \qquad (8)$$

where:
- i = Accounting method
- j = Firm
- a = Accounting period
- PE = Permanent earnings
- α,β = Intercept and slope coefficients
- P = Accounting Earnings

In like fashion, a transformation function for permanent rate of return (PROR) was derived. Axiom 4 of Greenball's permanent earnings concept delimits PROR as a constant over time by defining the ratio of earnings to capital to be equiproportional over the life of the firm.[22] Moreover, due to the arbitrary nature of an allocation process, rather than compute a sequence of period-by-period PROR's a single value was used for each firm. Correspondingly, since the dependent variable was constant a regression technique was not feasible.

Alternatively, two transformation functions were developed—multiplicative and additive. These are summarized as follows:

Multiplicative: $$PROR_{j,a} = CON_{i,j} \cdot \overline{AROR}_{i,j,a} \quad \text{For } \begin{matrix} i=1,8 \\ j=1,200 \\ a=1,59 \end{matrix} \qquad (9)$$

Additive: $$CROR'_{j,a} = CON'_{i,j} + \overline{AROR}_{k,j,a} \quad \text{For } \begin{matrix} i=1,8 \\ j=1,200 \\ a=1,59 \end{matrix} \qquad (10)$$

where: CON = multiplicative constant

CON' = additive constant

$\overline{AROR}$ = average accounting rate of return over all accounting periods

Step 2 A second set of multiple regressions were then run which regressed the stochastic parameters associated with each firm against α_i, β_i, CON_i, and CON'_i. The rationale for this stage is that an investor could identify certain firm-specific attributes which would be similarly employed to develop a transformation function. While this study's regression was limited to five independent variables an investor obviously could use as many as he deemed relevant.[23]

The regressions were run across all 200 firms and can be expressed as follows:

$$\alpha_i = a_{0,i} + a_{1,i}\,(FRST_j) + a_{2,i}\,(DEPR_j) + a_{3,i}\,(GROW_j) + a_{4,i}\,(CVAR_j) + a_{5,i}\,(ALCR_j) \quad \text{for } \begin{matrix} i=1,8 \\ j=1,200 \end{matrix} \qquad (11)$$

$$\beta_i = b_{0,i} + b_{1,i}\,(FRST_j) + b_{2,i}\,(DEPR_j) + b_{3,i}\,(GROW_j) + b_{4,i}\,(CVAR_j) + b_{5,i}\,(ALCR_j) \quad \text{for } \begin{matrix} i=1,8 \\ j=1,200 \end{matrix} \qquad (12)$$

$$CON_i = c_{0,i} + c_{1,i}\,(FRST_j) + c_{2,i}\,(DEPR_j) + c_{3,i}\,(GROW_j) + c_{4,i}\,(CVAR_j) + c_{5,i}\,(ALCR_j) \quad \text{for } \begin{matrix} i=1,8 \\ j=1,200 \end{matrix} \qquad (13)$$

$$CON'_i = c'_{0,i} + c'_{1,i}(FRST_j) + c'_{2,i}(DEPR_j) + c'_{3,i}(GROW_j) + c'_{4,i}(CVAR_j) + c'_{5,i}(ALCR_j) \quad \text{for } i=1,8;\ j=1,200 \tag{14}$$

Step 3 The third step involved running the simulation model a second time to derive a set of eight accounting earnings and ROR figures for a second groups of 200 firms and the associated permanent earnings and PROR for each.[24]

The five independent variables used in the Step Two regressions were estimated for each firm by employing a maximum likelihood estimator function.[25]

Step 4 The estimated independent variables were then input into four regression equations (using the coefficients derived in Step Two) to estimate values for $\alpha_{i,j}$, $\beta_{i,j}$, $CON_{i,j}$, and $CON'_{i,j}$ as follows:

$$\hat{\alpha}_{i,j} = a_{0,i} + a_{1,i}(\widehat{FRST_j}) + a_{2,i}(\widehat{DEPR_j}) + a_{3,i}(\widehat{GROW_j}) + a_{4,i}(\widehat{CVAR_j}) + a_{5,i}(\widehat{ALCR_j}) \quad \text{for } i=1,8;\ j=1,200 \tag{15}$$

$$\hat{\beta}_{i,j} = b_{0,i} + b_{1,i}(\widehat{FRST_j}) + b_{2,i}(\widehat{DEPR_j}) + b_{3,i}(\widehat{GROW_j}) + b_{4,i}(\widehat{CVAR_j}) + b_{5,i}(\widehat{ALCR_j}) \quad \text{for } i=1,8;\ j=1,200 \tag{16}$$

$$\widehat{CON}_{i,j} = c_{0,i} + c_{1,i}(\widehat{FRST_j}) + c_{2,i}(\widehat{DEPR_j}) + c_{3,i}(\widehat{GROW_j}) + c_{4,i}(\widehat{CVAR_j}) + c_{5,i}(\widehat{ALCR_j}) \quad \text{for } i=1,8;\ j=1,200 \tag{17}$$

$$\widehat{CON'}_{i,j} = c'_{0,i} + c'_{1,i}(\widehat{FRST_j}) + c'_{2,i}(\widehat{DEPR_j}) + c'_{3,i}(\widehat{GROW_j}) + c'_{4,i}(\widehat{CVAR_j}) + c'_{5,i}(\widehat{ALCR_j}) \quad \text{for } i=1,8;\ j=1,200 \tag{18}$$

These estimated values of α, β, CON, and CON' plus the associated raw accounting earnings and average accounting rate of returns (from Step Three) were finally input into the original regression equation to derive predicted values for permanent earning and permanent rate of return (under both models).

The transformation models can, therefore, be summarized as follows:

$$\widehat{PF}_{i,j,a} = \hat{\alpha}_{i,j} + \hat{\beta}_{i,j} \cdot F_{i,j,a} \quad \text{for} \quad \begin{matrix} i=1,8 \\ j=1,200 \\ a=1,59 \end{matrix} \tag{19}$$

$$\widehat{PROR}_{i,j} = \widehat{CON}_{i,j} \quad \overline{AGOR}_{i,j} \quad \text{for} \quad \begin{matrix} i=1,8 \\ j=1,200 \end{matrix} \tag{20}$$

$$\widehat{PROR'}_{i,j} = \widehat{CON'}_{i,j} + \overline{AROP}_{i,j} \quad \text{for} \quad \begin{matrix} i=1,8 \\ j=1,200 \end{matrix} \tag{21}$$

The evaluation of these predicted values is discussed in a later section.

C) Phase II - Stage I

In this phase the basic simulation model was modified such that input price changes occurred twice during each decision period. As in the Phase I model, the first price change occurs immediately preceeding the second production moment. The second price change occurred after the production decision and first production moment but prior to the end of the accounting period. The justification for this variation was two-fold. First, did Greenball's assumption of a singular price change unduly constrain the model--and hence the results?[26] Second, in a "real-world" setting, prices can change randomly. Given the structure of the model, this dual price change, therefore, mirrors the reality of the environment.

The second attribute of this simulation run was the use of "raw" accounting data. That is, no transformations were employed.

D) Phase II - Stage II

In this final stage, the model was varied to include the dual price change in addition to the estimation of transformation functions. Since both variations have been previously discussed, no further descriptions are necessary.

Figure Two summarizes the major variations from the basic model (described in Section III) which were tested in this study.

	Phase I	Phase II
Stage I	Single Price Change Comparison of Measured Earnings & ROR	Dual Price Change Comparison of Measured Earnings & ROR
Stage II	Single Price Change Comparison of Predicted Earnings & ROR	Dual Price Change Comparison of Predicted Earnings & ROR

Figure Two

VI) PERFORMANCE INDICES AND COMPARISONS

For each of the four simulation runs a series of earnings and rate of return values were determined by firm (j). These include: (1) the permanent earnings for each accounting period a, $PE_{a,j}$, (2) the permanent rate of return, $PROR_j$, (3) accounting earnings under each method i for every accounting period a, $P_{i,j,a}$, and (4) the corresponding rate of return, $ROR_{i,j,a}$. In addition, for the Stage II simulation runs transformed values were calculated for: (1) the predicted permanent earnings under each accounting method i for each accounting period a, $\widehat{PE}_{i,j,a}$ and (2) the predicted permanent rates of return: (a) $\widehat{PROR}_{i,j}$--multiplicative transformation function and (b) $\widehat{PROR}'_{i,j}$--additive transformation function.

Utilizing this data, a series of eight performance indices were computed for each accounting method i by firm j. These indices are identified in Table Three.

While this study utilizes the same six indices as Greenball an additional index was calculated relating to the error of both earnings and rate of return

Table 3

Performance Indices

INDEX	SYMBOL	DEFINITION*
Earnings Estimates:		
Mean Error--"U" coefficient	$XU_{i,j}$	$= \dfrac{\sqrt{\sum_a (P_{i,j,a} - PE_{j,a})^2}}{\sqrt{\sum_a (P_{i,j,a})^2} + \sqrt{\sum_a (PE_{j,a})^2}}$
Mean Relative Error	$XL_{i,j}$	$= \dfrac{1}{Aj^*} \sum_a \dfrac{\lvert P_{i,j,a} - PE_{j,a} \rvert}{PE_{j,a}}$
Mean Squared Relative Error	$XQ_{i,j}$	$= \dfrac{1}{Aj^*} \sum_a \left(\dfrac{P_{i,j,a} - PE_{i,j,a}}{PE_{j,a}} \right)^2$
Mean Relative Bias	$XB_{i,j}$	$= \dfrac{1}{Aj^*} \sum_a \dfrac{P_{i,j,a} - PE_{j,a}}{PE_{j,a}}$
Rate of Return Estimates:		
Mean Error--"U" coefficient	$RU_{i,j}$	$= \dfrac{\sqrt{\sum_a (AROR_{i,j,a} - PROR_j)^2}}{\sqrt{\sum_a (AROR_{i,j,a})^2} + \sqrt{\sum_a (PROR_j)^2}}$
Mean Error	$RL_{i,j}$	$= \dfrac{1}{Aj^*} \sum_a \lvert AROR_{i,j,a} - PROR_j \rvert$
Mean Squared Error	$RQ_{i,j}$	$= \dfrac{1}{Aj^*} \sum_a (AROR_{i,j,a} - PROR_j)^2$
Mean Bias	$RB_{i,j}$	$= \dfrac{1}{Aj^*} \sum_a (AROR_{i,j,a} - PROR_j)$

*A_j refers to the number of accounting periods in the life of firm j--(i.e. $A_j = T_j - 1$)

values. Theil offers a discussion of the traditional method of forecasting, its problems and an alternative--a "U" coefficient.

> "One of the measures that has sometimes been used for analyzing the accuracy of forecasts is the classical (product-moment) correlation coefficient of the series of predictions and actual outcomes. Its disadvantage is that perfect (positive) correlation does not imply perfect forecasting, but only the existence of an exact linear relation with positive slope between the individual predictions (P_i) and the actual values (A_i),
>
> $$P_i = \alpha + \beta \cdot A_i \qquad \beta > 0$$
>
> whereas perfect forecasting requires, in addition to this, $\alpha = 0$ and $\beta = 1$. An alternative coefficient, viz.
>
> $$U = \frac{\sqrt{\frac{1}{n} \Sigma (P_i - A_i)^2}}{\sqrt{\frac{1}{n} \Sigma P_i^2} + \sqrt{\frac{1}{n} \Sigma A_i^2}}$$
>
> $P_1,\ldots,P_n$ being the predictions and $A_1,\ldots,A_n$ the corresponding actual outcomes, is preferable in this respect. (Emphasis added) We shall call it the inequality coefficient of the series P_i, A_i." [27,28]

In addition to Theil's theoretical justification for the U coefficient a pragmatic rationale also exists. The mean squared relative error index (XQ) can potentially "explode". That is, in a given period if the accounting earnings ($P_{i,j,a}$) for a firm j are unusually large vis a vis the permanent earnings of that period ($PE_{j,a}$) the XQ value will be extremely large [29] Similarly the XL and XB values will also be relatively large, in such periods, though not as extreme as the XQ--due to the squaring operation utilized in deriving XQ.[30] Accordingly, the "U" coefficient which is not subject to such fluctuations, was utilized as the major statistic measuring error between the accounting measure versus the permanent measure for both earnings and rate of return.

The evaluations made in this study were based on paired comparisons between the sample means of each of the eight indices. The sample means were calculated by finding an average value for each index across all firms.[31]

The sample means for each of the simulation runs can be found in Tables Four through Seven.

TABLE FOUR

SAMPLE MEANS OF PERFORMANCE INDEX VALUES

PHASE I - STAGE I

	Accounting Method							
Index	1(HA)	2(HD)	3(BA)	4(BD)	5(CA)	6(CD)	7(N)	8(N+)
XU	.06437	.06639	.08090	.09023	.07778	.07012	.09781	.09896
XL	.13837	.14821	.16841	.18548	.16095	.16173	.17481	.15368
XQ	.03020	.03543	.04577	.05436	.04038	.04051	.04979	.04274
XB	-.10563	-.12305	-.11995	-.13553	-.12679	-.14475	-.12198	-.01409
RU	.11808	.16835	.15294	.19494	.12540	.16117	.16786	.17487
RL	.04460	.06785	.05616	.07592	.04573	.06275	.06117	.07015
RQ	.00369	.00728	.00550	.00934	.00424	.00688	.00641	.00795
RB	.03195	.05015	.02500	.04257	.02228	.03922	.02688	.05374

TABLE FIVE

SAMPLE MEANS OF PERFORMANCE INDEX VALUES

PHASE I - STAGE II

	Accounting Method							
Index	1(HA)	2(HD)	3(BA)	4(BD)	5(CA)	6(CD)	7(N)	8(N+)
XU	.12203	.13686	.17052	.18679	.12096	.12769	.23366	.22096
XL	.25730	.27192	.29630	.21064	.25515	.26402	.33179	.32394
XQ	.10263	.11015	.12276	.13055	.10118	.10618	.14497	.14011

Table Five, cont.

Index	1(HA)	2(HD)	3(BA)	4(BD)	5(CA)	6(CD)	7(N)	8(N+)
XB	.12459	.11782	.12303	.11851	.13074	.12160	.12906	.12461
RU	.10703	.13372	.14840	.17218	.12668	.14491	.16279	.13578
RL	.03655	.04414	.05228	.05987	.04471	.04926	.05552	.04539
RQ	.00252	.00354	.00469	.00597	.00410	.00471	.00557	.00402
RB	.00567	.00532	.01004	.00917	.01331	.01191	.00748	.00715

T A B L E S I X

SAMPLE MEANS OF PERFORMANCE INDEX VALUES

PHASE II - STAGE I

	Accounting Method							
Index	1(HA)	2(HD)	3(BA)	4(BD)	5(CA)	6(CD)	7(N)	8(N+)
XU	.07682	.07496	.13445	.11263	.14683	.13117	.15450	.16823
XL	.15558	.16230	.23124	.21269	.22062	.21266	.23609	.24372
XQ	.03780	.04243	.07828	.06801	.07363	.06916	.08347	.08905
XB	-.11111	-.12817	-.11140	-.12492	-.12090	-.13963	-.11079	-.02554
RU	.13899	.19395	.18293	.20423	.21887	.24741	.20026	.21404
RL	.05412	.08034	.06981	.08141	.08010	.09706	.07508	.08670
RQ	.00515	.01002	.00797	.01085	.01261	.01736	.00939	.01214
RB	.03692	.05651	.02751	.04510	.03035	.04860	.02666	.05248

TABLE SEVEN

SAMPLE MEANS OF PERFORMANCE INDEX VALUES

PHASE II STAGE II

	Accounting Method							
Index	1(HA)	2(HD)	3(BA)	4(BD)	5(CA)	6(CD)	7(N)	8(N+)
XU	.18243	.19768	.25701	.24163	.26774	.26245	.29350	.29474
XL	.28805	.30171	.33916	.33081	.33968	.33948	.35953	.36014
XQ	.11920	.12633	.14638	.14174	.14721	.14728	.15916	.15921
XB	.10422	.10945	.08510	.08895	.07653	.08318	.10910	.10295
RU	.12076	.15120	.17596	.18035	.21307	.22364	.18952	.17857
RL	.14011	.04867	.06016	.06176	.07276	.07695	.06541	.06083
RQ	.00277	.00420	.00615	.00632	.01052	.01120	.00717	.00631
RB	.00499	.00457	.00927	.00865	.01863	.01642	.00771	.00794

The emphasis of this study was comparisons between alternative methods rather than a ranking of the absolute performances of each. As such, a series of pairwise comparisons were made which are summarized below:

(1) Absorption costing vs. Direct Costing { (HA vs. HD), (BA vs. BD), (CA vs. CD) }

(2) Historical cost vs. Business Profit { (HA vs. BA), (HD vs. BD) }

(3) Historical cost vs. Current operating profit { (HA vs. CA), (HD vs. CD) }

(4) Business profit vs. Current operating profit — (BA vs. CA); (BD vs. CD)

(5) Net realizable value vs. Historical cost absorption — (N vs. HCA); (N+ vs. HCA)

(6) Net realizable value vs. Business profit absorption — (N vs. BA); (N+ vs. BA)

(7) Net realizable value vs. Current operating profit absorption — (N vs. CA); (N+ vs. CA)

These fifteen comparisons were made for all four of the simulation runs--i.e., both phases and both stages. In addition, for each of the eight methods, pairwide comparisons were made between Phase I and Phase II results. That is, are the predicted (transformed) values for earnings ($\widehat{PE}_{i,j,a}$) and rate of return ($\widehat{PROR}_{i,j}$ and $\widehat{PROR}'_{i,j}$) significantly better estimates of actual permanent earnings and permanent rate of return than the "raw" accounting values?[32]

For purposes of testing the statistical significance of each comparison the "student's t" test was utilized. For the sake of brevity, the sample stand errors and t-ratios have been omitted. Tables Eight through Eleven which summarize these results indicates the level of significance attached to each paired comparison.

Performance Index	Absorption vs. Direct: HA vs HD	Absorption vs. Direct: BA vs BD	Absorption vs. Direct: CA vs CD	HC vs. BP: HA vs BA	HC vs. BP: HD vs BD	HC vs. CDP: HA vs CA	HC vs. CDP: HD vs CD	BP vs. CDP: BA vs CA	BP vs. CDP: BD vs CD	NRV vs. HCA: A vs HA	NRV vs. HCA: M vs BA	NRV vs. BCA: A vs BA	NRV vs. BCA: M vs BA	NRV vs. CDP: A vs CA	NRV vs. CDP: M vs CA
XU		+		+	+	+	+*		-	-	-	-	-	-	-
XL	+*	+		+	+	+				-	-		+	-	
XQ	+	+		+	+	+	+*		-	-	-			-	
XB	+	+	+	+*	+	+	+			-	+		+		+
RU	+	+	+	+	+			-	-	-	-	-	-	-	-
RL	+	+	+	+	+			-	-	-	-	-*	-	-	-
RQ	+	+	+	+	+			-*	-	-	-	-*	-	-	-
RB	+	+	+	-*	-*	-	-				-		-		-

TABLE EIGHT

Phase I - Stage I

NOTATION:
- \+ Indicates first method significantly (at .01 level) better than second method.
- \- Indicates second method significantly (at .01 level) better than first method.
- * Significant at .05 level.
- "Blank" Neither method significantly different from other.

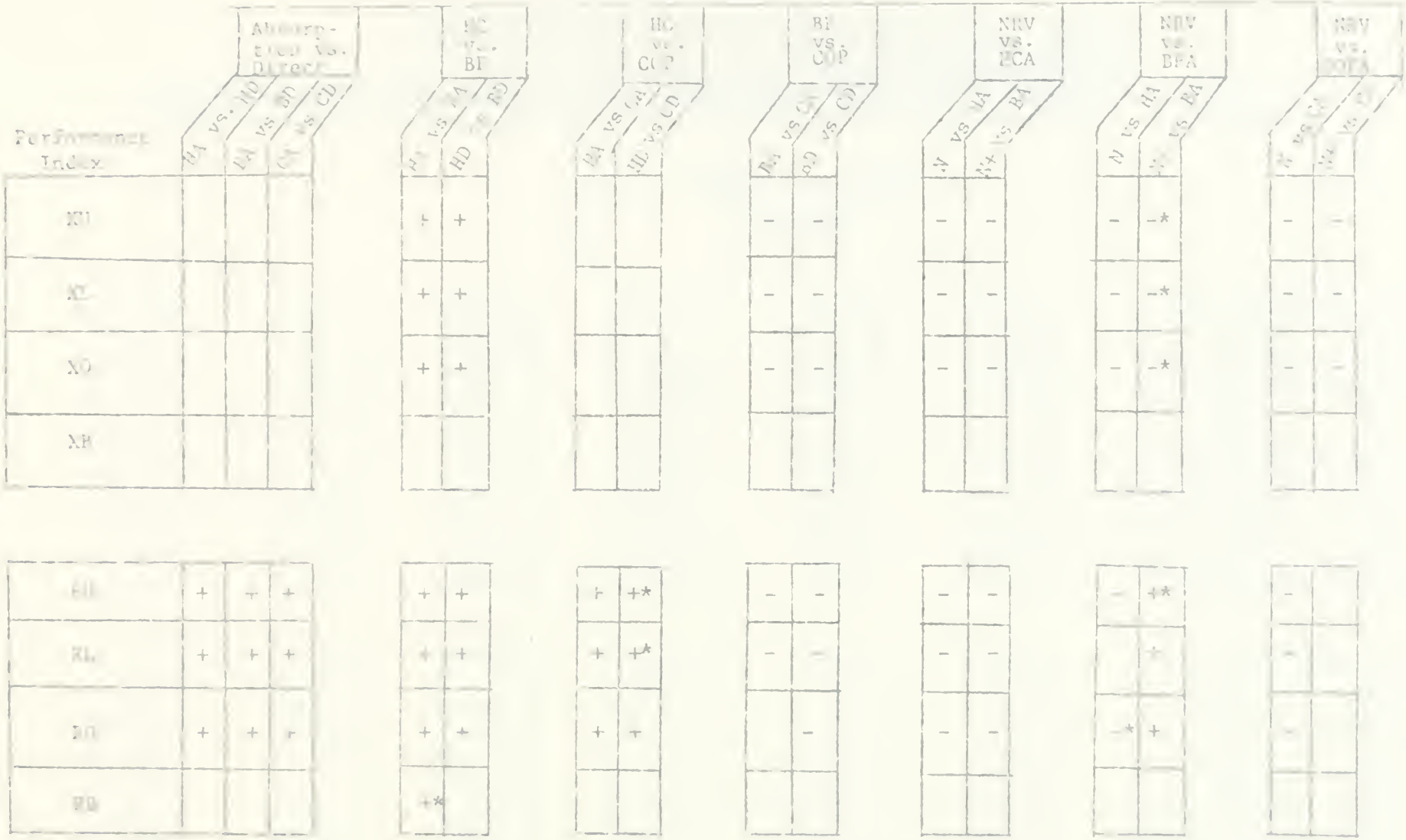


TABLE NINE

Phase I - Stage II

NOTATION: + Indicates first method significantly (at .01 level) better than second method.
- Indicates second method significantly (at .01 level) better than first method.
* Significant at .05 level.
"Blank" Neither method significantly different from other.

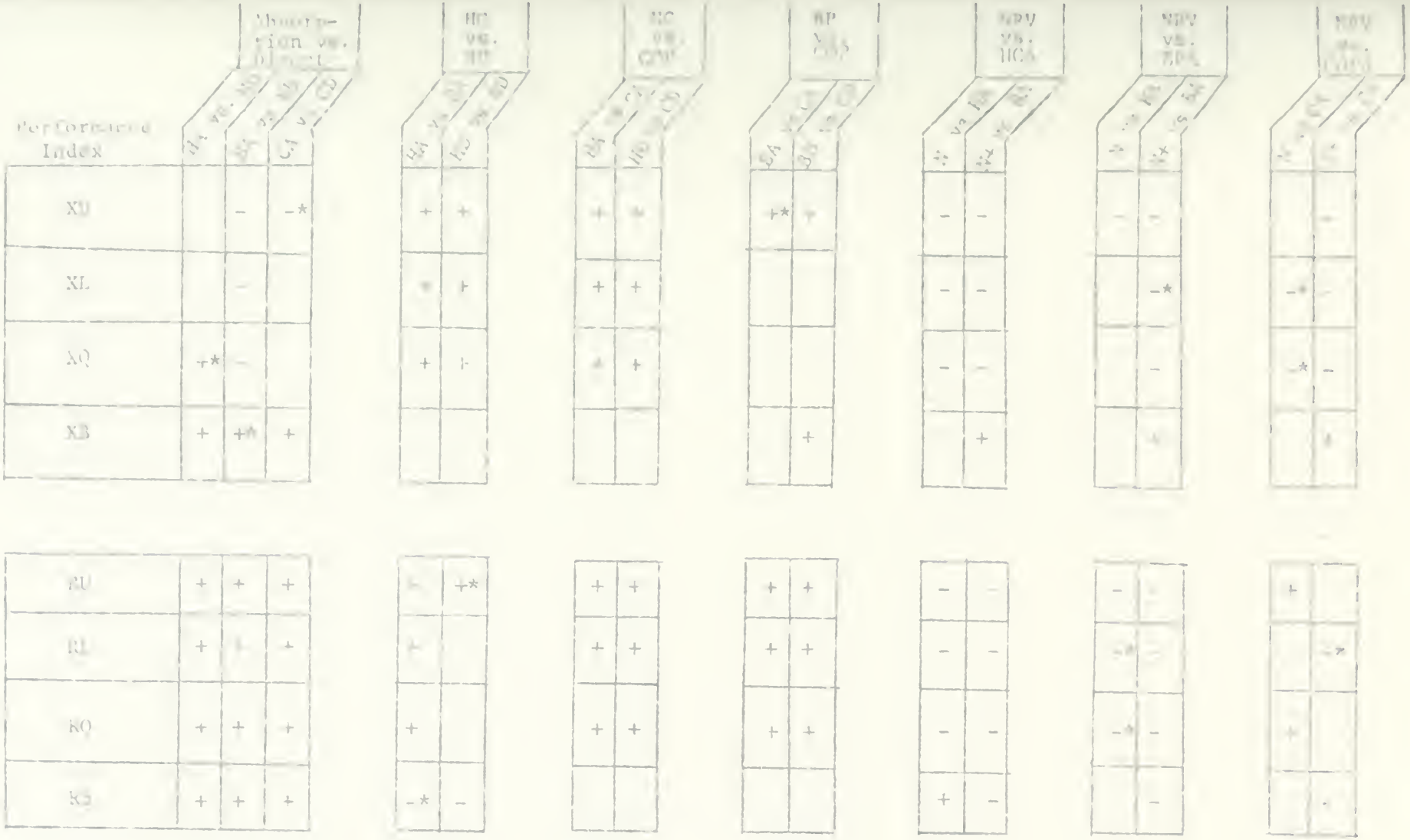


TABLE TEN

Phase II - Stage I

NOTATION: + Indicates first method significantly (at .01 level) better than second method.
- Indicates second method significantly (at .01 level) better than first method.
* Significant at .05 level.
"Blank" Neither method significantly different from other.

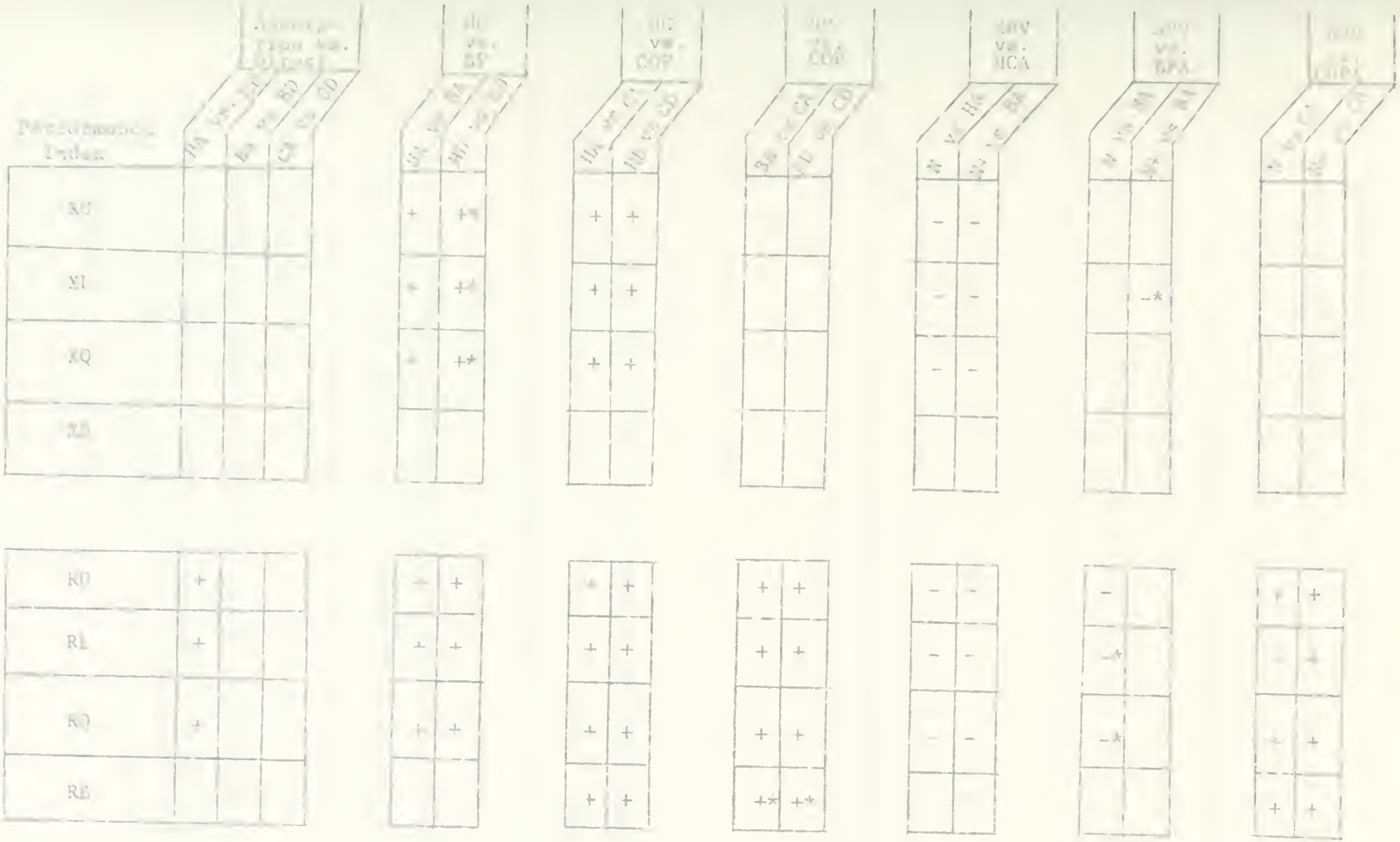


TABLE ELEVEN

Phase II - Stage II

NOTATION: + Indicates first method significantly (at .01 level) better than second method.
- Indicates second method significantly (at .01 level) better than first method.
* Significant at .05 level.
"Blank" Neither method significantly different from other.

Given the multi-dimensional nature of this study the presentation and interpretation of the results have been partitioned into four major segments. These analyses include the following: (1) replication of Greenball, (2) comparisons between accounting methods under the dual price change assumption, (3) comparison (by individual accounting method) of results generated under singular price change versus dual price change assumptions, and (4) comparison of actual versus predicted results.

A) Replication of Greenball's Study

The results of this segment (Phase I- Stage I) of the study basically parallel Greenball's results. Rather than reiterating his analysis this discussion is limited to an identification of the discrepancies from his earlier findings.[33]

1) Absorption versus Direct Costing

a) Earnings

While the XL, XO, and XB indices indicated the absorption costing methods outperformed their direct costing counterparts, discrepancies with Greenball's results were discovered with respect to levels of significance. Specifically, while historical cost absorption (as measured by XL) more closely approximated permanent earnings than HD the degree of significance was at the .05 level rather than the .01 level as reported by Greenball. Likewise, while this study found CA outperforming CD no level of significance could be attached to this difference.

Alternatively, while Greenball's findings indicate less bias in all absorption costing methods than the directing costing techniques no level of significance could be attached to this difference.[34] This study determined that such differences were significant at the .01 level.

b) Rate of Return

The findings of this study completely supported Greenball's results--both in terms of the superiority of absorption methods as well as the level of significance of the differences.

2) Historical Cost versus Nominal Profit

a) Earnings

As Greenball found, both the historical methods (HA and HD) outperformed their business profit complements (BA and BD). However, while Greenball's results as to bias found insignificant differences favoring H, this study found these differences to be significant--at the .05 level in favor of HA and the .01 level for HD.

b) Rate of Return

Both H methods outperformed their B counterparts at the .01 level as Greenball's findings indicate.

Here again, while Greenball found insignificant results favoring B with respect to bias, this study determined these findings significant at the .01 level.

3) Historical Cost versus Current Operating Profit

a) Earnings

While Greenball found insignificant (and contradictory) results favoring the CP methods this study found quite opposite results.[35] HA significantly (.01 level) outperformed CA both in terms of error and bias. Alternatively, while HD were closely approximated the permanent earnings than BD no significant difference was found in the XL measure though the XQ and XB measures were significantly different in favor of H at the .05 and .01 levels respectively.

b) Rate of Return

Again the results of this study closely parallel Greenball's findings. That is, neither the HL nor HQ indices identified significant results favoring

one method over the other. However, while Greenball found the C method outperforming H with respect to bias an analysis of his findings discovered no level of significance could be attached to these differences.[36] This study found H significantly (.01 level) outperforming B in terms of bias both for their absorption and direct costing methods.

4) Business Profit versus Current Operating Profit

a) Earnings

While the results of this study support Greenball's observation (i.e. current operating profit outperforms business profit) the level of significance for all indices (XL, XQ, and XB) could not support a "blanket" statement as to the superiority of business profit.

b) Rate of Return

The findings of this study completely support Greenball's observations that current operating profit methods outperformed their business profit counterparts.

In addition to replicating the earlier findings of Greenball this study utilized the same simulation model to generate two addition streams of earnings measured via the net realizable value earnings (NRV) concept. Since both variations include overhead as a component in inventory valuation the findings described below are limited to comparisons of each net realizable value method with the corresponding absorption costing method.

1) Net Realizable Value versus Historical Cost Absorption

a) Earnings

Utilizing each of the error indices (XU, XL, and XQ) historical cost absorption outperformed both the unadjusted and adjusted (for "market differential") net realizable value methods of earnings measurement.[37] However, while HA understated earnings to a significantly lesser degree than unadjusted NRV(S),

the adjusted net realizable value (N+) outperformed HA.

b) Rate of Return

Consistent with the performance of the earnings streams HA significantly outperformed the two NRV methods with respect to error. Here again, the findings regarding the bias of the methods was somewhat inconclusive. The unadjusted NRV earnings stream produced a smaller degree of bias than HA but the difference was not significant even at the .05 level. Conversely from the earnings comparisons the HA method significantly outperformed N+.

2) Net Realizable Value versus Business Profit Absorption

a) Earnings

In this comparison discrepancies were discovered based on the index employed to evaluate the three methods. Based on intrinsic deficiencies in the XL and XQ measures identified by Greenball, the "U" coefficient of Theil was deemed a "better" measure of performance.[38] Accordingly, the findings indicate the earnings streams generated under the HA technique more closely approximated the correspondent permanent earnings stream than either of the two NRV methods. Alternatively, while HA produced less bias than either NRV method the difference was not significant--though the adjusted (N+) stream did significantly outperform HA with respect to bias.

b) Rate of Return

Again employing the "U" statistic the HA method significantly achieved a closer correspondence to the permanent earnings stream than either of the NRV techniques with respect to error. Similarly, HA tended to overstate ROR to a lesser degree than both NRV methods though the difference was not significant for the unadjusted NRV earnings (N).

3) Net Realizable Value versus Current Operating Profit Absorption

a) Earnings

Here again the net realizable value methods proved significantly inferior to the alternative--in this case CA--with respect to error. Alternatively, the superiority of the CA methods did not hold regarding bias. Both net realizable value methods outperformed the CA technique though the difference was not significant for the unadjusted NRV.

b) Rate of Return

The CA measure of ROI produced a stream of earnings that corresponded to permanent earnings significantly better than the NRV methods regarding error. Similarly, CA was less upward biased than either NRV method though the difference was insignificant with respect to the unadjusted technique (N).

B) Dual Price Change Comparisons

One of the major extensions of Greenball's earlier study was the inclusion of a second input price change during each decision period. As described earlier the second change occurs immediately preceeding the end of the accounting period--Figure One graphically depicts the relevant time relationships. Accordingly this extension of the basic model imparted upon both earnings and rate of return since inventory valuation was affected. As such it would appear the findings of this simulation model would have greater generalizability than the single price change given the dynamic movement of prices in today's economy.

This section of the paper deals solely with comparisons within the appropriate segment of the total study--i.e., Phase II - Stage I. The next section will compare the results between alternative methods as found in the more generalizable dual price change simulation.

1) Absorption Costing versus Direct Costing

a) Earnings

Utilizing the "Q" statistic identified by Theil the results indicate that in all cases the direct methods outperformed their absorption counterparts with respect to error.[29] However, varying levels of significance were found. Specifically, while no significant difference was found between the B methods, the A methods were significantly different at the .01 level and the C techniques were different at the .05 level. Conversely, the absorption methods were significantly (.01 level) less downward biased (from permanent earnings) than their corresponding direct measures.

b) Rate of Return

In all cases (A, B and C) the absorption costing methods significantly (.01 level) outperformed their direct costing techniques both with respect to error and bias.

2) Historical Cost versus Business Profit

a) Earnings

Both historical cost methods produced less error in estimating permanent earnings than the analogous business profit techniques. Conversely, BA outperformed AA while BD outperformed AD with respect to bias. However, neither measure of bias was significant even at the .05 level.

b) Rate of Return

Similar to the findings regarding earnings, both historical cost methods produced less error in estimating permanent earnings than the corresponding business profit techniques--though the difference was significant only at the .05 level for the direct costing methods. Alternatively, both B methods outperformed their A counterparts--with respect to bias--but only at the .01 level for the absorption methods.

3) Historical Cost Versus Current Operating Profit

a) Earnings

For both A and D the historical cost measures outperformed their corresponding current profit measures with respect to error and bias. However, the differences regarding bias were not significant at the .05 level.

b) Rate of Return

The historical cost measures (HA and HD) produced significantly less estimation error than their current operating profit counterparts. Conversely, the latter did not overstate the rate of return regarding bias as much as the H methods--although the differences were not significant.

4) Business Profit Versus Current Operating Profit

a) Earnings

The findings indicate the B methods achieved a lower degree of error and bias than the analogous C methods. However, the absorption method's differences were not significant at the .05 level.

b) Rate of Return

Both B methods produced significantly less error in estimating permanent earnings than the C methods. Similarly, while the B methods outperformed their C counterparts regarding bias no level of significance could be attached to the differences.

5) Net Realizable Value Versus Historical Cost Absorption

a) Earnings

As in the Phase I-Stage I comparisons all discussions of net realizable value and alternative measures (H, B and C) are limited to the absorption costing results of the respective alternatives. Hence, the findings of the HA versus the NRV comparisons indicate HA outperformed both the unadjusted (N) and adjusted (N+) alternatives regarding error. Conversely, both NRV methods produced

less bias in estimating permanent earnings though the difference between the adjusted (N) measure and HA was not significant.

b) Rate of Return

Historical absorption outperformed both NRV methods at the .01 level with respect to error. The results regarding bias were somewhat opposed. That is, unadjusted NRV produced less bias in estimating permit rate of return than HA while HA produced less bias than the adjusted NRV method. Both bias comparisons were significant at the .01 level.

6) Net Realizable Value Versus Business Profit Absorption

a) Earnings

Business profit absorption significantly outperformed both NRV methods regarding error. Conversely, both NRV methods understated earnings less than BA although the difference was not significant for the unadjusted NRV.

b) Rate of Return

Here also the BA measure of rate of return produced less estimation error than the NRV alternative. Regarding bias, the unadjusted NRV narrowly (i.e, not significant at .05 level) outperformed BA though BA overstated the rate of return to a significantly lesser degree than N+.

7) Net Realizable Value Versus Current Operating Profit Absorption

a) Earnings

Current operating profit absorption produced less estimation error than either NRV methods although a significant difference was found only for the comparison between N+ and CA. Contrasting these findings, the NRV methods outperformed CA regarding bias but only the comparison between CA and N+ was significant.

b) Rate of Return

Both NRV methods outperformed CA with respect to error though the difference was not significant for the N+ comparison. However, the findings

regarding bias were somewhat conflicting. N produced a smaller (but insignificant) bias in estimating permanent rate of return than CA. Alternatively, CA significantly outperformed N+ regarding the bias index.

C) Comparison of Singular Versus Dual Price Change Results

This section of the paper will directly compare the results of the singular price change (Phase I-Stage I) versus the findings of the dual price change (Phase II-Stage I). As described earlier the dual price change model more closely replicates a real world situation in that input prices can change randomly. As such, the findings of the dual price change simulation are the more generalizable. Hence, major differences between the two simulation models will be identified. Again, all comparisons of "error" will be limited to the "U" statistic.

1) Absorption Versus Direct Costing

a) Earnings

Several dramatic reversals occurred between the Phase I and Phase II findings with respect to error. While HA, BA and CA were found to outperform their direct counterparts in Phase I the results were diametrically opposed in Phase II. That is, all three direct costing methods produced less estimation error than the corresponding absorption methods--although with varying degrees of level of significance (see Table Ten). These findings are noteworthy since Greenball's (and Phase I's) results indicate absorption methods superior to the corresponding direct methods. However, with respect to bias the absorption costing methods (in Phase II) continued to outperform their direct costing counterparts.

b) Rate of Return

No changes were found with respect to error nor bias.

2) Historical Cost Versus Business Profit

a) Earnings

No differences were found regarding error between the two models. However, with respect to bias the case for historical cost became much weaker (or even reversed). While HA outperformed BA in both phases the results of the dual price change model (Phase II) were not statistically significant. A complete reversal occurred in the direct costing comparisons. In Phase I HD was found to significantly outperform BD; yet Phase II found BD outperforming HD (though no level of significance could be attained to the latter case.)

b) Rate of Return

The historical methods produced less estimation error than their business counterparts in both phases--although the level of significance decreased (to the .05 level) for the direct cost comparison in Phase II. Similarly, the business profit methods outperformed the corresponding historical cost methods regarding bias--though with different levels of significance. (See Tables 8 and 10.)

3) Historical Cost Versus Curren Operating Profit

a) Earnings

The superiority of historical cost regarding error was further accentuated in the Phase II results. Both HA and HD significantly outperformed their CP counterparts. These findings suggest a dramatic reversal of Greenball's study which found that CP "narrowly outperformed the H methods." Similarly, with respect to bias, the Phase II results, while still indicating the historical methods understated the permanent earnings to a lesser degree than the corresponding CP methods, were not significant even at the .05 level.

b) Rate of Return

Here also significant variance was found between both Greenball's and Phase I's results. Specifically, both historical methods produced less

error in estimating permanent earnings than the current profit methods. Moreover, these findings were significant at the .01 level. Regarding the ROR bias (RB) the same relationship was found as in the case of earnings. That is, while both CA and CD outperformed their historical counterparts in Phase II, these results were not statistically significant at even the .05 level.

4) Business Profit Versus Current Operating Profit

a) Earnings

Here again, significant reversals occurred between Greenball's (and Phase I's) findings and the dual price change simulation. While the C methods outperformed their B methods in the singular price change simulation the results were completely inverted in Phase II. That is, both business profit methods outperformed their corresponding current profit alternatives although the absorption costing comparison (BA vs. CA) was not significant at the .05 level. With respect to bias both Phase I and Phase II's findings indicate the B methods understated permanent earnings to a lesser degree than the C alternatives. However, varying levels of significance were again found (see Tables 8 and 10).

b) Rate of Return

Comparisons of the "U" statistic again found a complete reversal of the results between Phase I and Phase II. In the dual price change simulation both BA and BD significantly outperformed the CA and CD methods regarding error. Likewise, the measure of bias (RB) indicated a reversal from Phase I to Phase II's findings. Phase I (and Greenball) found the C methods overstating permanent ROR to a lesser extent than the corresponding B methods. Phase II indicated a turnabout with the B methods outperforming their C counterparts. However, it must be noted that neither the Phase I nor Phase II results were significant at even the .05 level.

5) Net Realizable Value Versus Historical Cost Absorption

a) Earnings

No difference were found in error between Phase I and Phase II. Alternatively, the unadjusted NRV understated permanent earnings to a lesser degree than HA in Phase II--although the findings were not significant at the .05 level. In both phases the adjusted NRV (N+) significantly outperformed the HA method.

b) Rate of Return

No differences were found between Phase I and Phase II's results other than the level of significance in the measure of bias. Specifically, the N method significantly performed the HA measure (at the .01 level) in Phase II while Phase I's results (although still favoring N) were not significant.

6) Net Realizable Value Versus Current Operating Profit Absorption

a) Earnings

The comparisons in Phase I and Phase II found the exact same relationships other than the level of significance in the measure of error. Specifically, while CA outperformed both NRV methods (regarding error) the difference was not significant in Phase II's comparison of CA versus the unadjusted NRV (N) method.

b) Rate of Return

An inversion of results was again found between the singular price change versus the dual price change simulation regarding error--and to a lesser extent--bias. That is, in Phase II both NRV methods were found to be better estimators of permanent earnings than the CA method--although the difference was not significant for the CA versus N+ comparison. Regarding bias, CA outperformed N+ in both phases. However, a reversal occurred in the unadjusted NRV comparison. That is, in Phase II N did not overstate the permanent ROR as much as CA though

neither the results of Phase I nor Phase II were statistically significant.

7) Net Realizable Value Versus Business Profit

a) Earnings

No difference were found between the two phases with respect to error. Regarding bias, in the BA versus N comparison BA was favored in Phase I while N understated permanent earnings to a lesser degree in Phase II--though neither difference was significant at the .05 level. The adjusted NRV significantly outperformed BA in both phases.

b) Rate of Return

BA outperformed both NRV methods in each phase with respect to error. However, a reversal again occurred in the measure of bias in the comparison of BA versus N. Phase I's findings indicate BA to be superior while Phase II's results suggested N outperformed the business profit alternative--again neither difference being significant. Finally, BA overstated permanent ROR to a significantly lesser degree than both NRV methods.

As a final determination of the significance of the differences between the two phases an analysis of variance (ANOVA) test was made. Specifically, the eight accounting models, the two phases, and their interactions were considered the independent variables, the "U" statistics and absolute rankings (for both earnings and rate of return) were used as the dependent variables and the 200 firms represented the "subjects."[40] The "F" ratios and their corresponding levels of significance are summarized in Table Twelve. As can be seen from the "F" ratios there is little doubt that the two phases generated significantly different streams of earnings and rates of return.

Independent / Dependent	Accounting Model (A)	Phase (B)	Model & Phase Interaction (AxB)
XU (income)	108.6 / 0.0	803.9 / 0.0	33.4 / 0.0
Ranking of XU's	378.6 / 0.0	0.0+ / .983	88.0 / 0.0
RU (ROR)	76.6 / 0.0	469.9 / 0.0	31.4 / 0.0
Ranking of RU's	480.9 / 0.0	0.0+ / .981	131.4 / 0.0

TABLE TWELVE

ANOVA Test Between Phases
(F Ratio/Level of Significance)

To summarize the comparison between Phase I-Stage I and Phase II-Stage I's findings:

1) Both earnings and rates of return (as measured by the "U" statistic and absolute rankings) were significantly different.
2) The sole distinction between the two phases was the inclusion of the second input price change in Phase II.
3) The findings of Phase II represent the more generalizable case. That is, the simulation model utilized in Phase II better mirrors the reality of somewhat random price changes found in the "real world."

4) Therefore, the results described by Greenball (and replicated in Phase I-Stage I) are heavily constrained to the rather unrealistic situation of input prices changing only once per year--immediately preceding the production decision. Accordingly, the findings of Phase II-Stage I (which reverse many of Greenball's conclusions) are offered as more realistic comparisons of alternative measurement schemes of accounting earnings.

D. Comparison of Actual Versus Predicted Earnings and Rates of Return

This segment of the study describes the comparison of Phase II-Stage I's findings versus those of Phase II-Stage II.[41] As previously described, the objective of Stage II was to determine if a set of transformation functions could be found (using historical accounting information) which, when applied to future period's accounting information, would generate an adjusted (or predicted) pair of figures that would prove better estimates of permanent income and permanent ROR than their unadjusted counterparts. Separate transformation functions were found (utilizing the methodology identified in Section V-B) for each of the eight accounting methods being evaluated based on Phase II-Stage I's results. These functions were then applied to the "raw" accounting information generated in Phase II-Stage II to derive the predicted values of income and ROR whose summary statistics can be found in Table Eleven.

The comparison of "actual" earnings and ROR (Phase II-Stage I) versus "predicted" earnings and ROR (Phase II-Stage II) was conducted in two steps: (1) analysis of variance and (2) "t" tests across "U" statistics for each accounting method.

1) Analysis of Variance

The initial step in comparing the "actual" versus "predicted" results took the form of an analysis of variance (ANOVA). Specifically, the

ANOVA test was utilized to determine if the two stages did, in fact, produce different results or whether the transformation functions uniformly changed the income and rate of return streams such that no significant differences occurred in the error statistics ("U's") or the absolute rankings. Accordingly, the eight accounting models, their two stages and the resulting interactions were identified as the independent variables, the "U" statistics and absolute rankings (for both earnings and rate of return) were utilized as the dependent variables, and the 200 firms represented the subjects. The "F" ratios and their corresponding levels of significance can be found in Table Thirteen.

Independent / Dependent	Accounting Model (A)	Stage (B)	Model & Stage Interaction (AxB)
XU (income)	39.2 / 0.00	223.6 / 0.0	0.3 / .957
Ranking of XU's	651.9 / 0.0	0.0+ / .981	4.2 / 0.00+
RU (ROR)	122.8 / 0.0	110.3 / 0.0	5.6 / 0.0
Ranking of RU's	487.2 / 0.0	0.0+ / .982	55.4 / 0.0

TABLE THIRTEEN
ANOVA Test Between Stages
(F Ratio/Level of Significance)

The conclusions which can be drawn from this test can be summarized as follows:

1) The "U" statistics generated for both earnings and rates of return were significantly different.
2) The absolute rankings (by "U" statistic--lowest to highest) of accounting models were significantly different. (No difference was found across stages since absolute rankings--i.e., 1 to 8 were used.)
3) Therefore, the ANOVA analysis indicates that the "actual" findings (Stage I) were, in fact, significantly different from the "predicted" findings (Stage II).

2) Comparisons by Individual Accounting Methods

The final aspect of the Stage I versus Stage II comparison dealt with individual accounting methods. That is, for both earnings and rates of return which accounting measures ("actual" or "predicted") provided a better estimate of permanent earnings and permanent ROR? Accordingly, paired comparisons of the "U" statistic for each accounting method were made through utilization of a "t" test. Table Fourteen summarizes these comparisons.

TABLE FOURTEEN

Pairwise Comparisons of Actual (Stage I) Versus Predicted (Stage II) Results (Significant at .01 Level)

Accounting Method \ Accounting Measure	Earnings (XU)	ROR (RU)
HA HD	A A	P P
BA BD	A A	P** P
CA CD	A A	P** P
[illegible] [illegible]+	A A	P* P

* = Significant at .05 Level

** = Not significant even at .05 Lev

From Table fourteen the following conclusions can be drawn:

1) The transformation functions used in converting "actual" earnings to "predicted" earnings uniformly produced a greater degree of estimation error. That is, for each accounting method the "actual" earnings significantly outperformed their "predicted" counterparts in estimating permanent earnings.

2) The transformation functions utilized in converting "actual" rates of return to "predicted" rates of return uniformly produced a smaller degree of estimation error. That is, for each accounting method the "predicted" ROR's outperformed (with varying levels of significance) their "actual" counterparts in predicting permanent rate of return.

VIII) Limitations

No research study is free from limitations imposed by the methodology--particularly when a simulation approach is utilized. As such, any research effort should set forth these limitations with two goals in mind. First, a specification of the limitations demarcate the boundaries within which the findings can be applied. Second, the designation and appreciation of the limitation can serve as a foundation for future research. Accordingly, the following limitations have been identified:

1) Permanent Earnings and Permanent Rate of Return Concepts--these concepts (as defined by Greenball) while theoretically sound still remain suspect with relation to the "users" of accounting information. That is, lacking a commonly accepted user "model" the dependence on these concepts may leave the results of the study subject to question.

2) Decision Function--The use of the expected cash flow maximization criterion can be attacked on the grounds of experimental reality. That is, while

theoretically such a criterion should be utilized to insure long run profit maximization, various authors have suggested other criteria are employed in the "real-world."[42]

3) Single Production Decision and Single Product--the simulation model used had but one production decision per period and one product. While it can be argued the time dimension of the production decision would not impact upon the results the effects of a multi-product firm are unknown.[43]

4) "Simplicity" of Income Statement--the simulation model represented a fairly simplistic situation with respect to income reporting. That is, depreciation was the only form of a "deferred charge" amortized over time. As such, the effect of alternative accounting principles or "income smoothing" could not be determined.

5) Price Stability--prices (both input and selling) were assumed basically constant over time. That is, the stochastic parameters used in the model were initially randomly selected from pre-specified distributions. Subsequent values were determined by the following equation

$$Value_t = (Value_{t-1})(1 + U_{Value_t}) \quad (22)$$

where U_{Value_t} represents a random variate with a normal distribution, zero mean, and a pre-specified variance.

IX) Extensions

Several extensions of this research effort have been identified and will be pursued in the future. These include:

1) Decomposition of the "U" statistic--as Theil describes the "U" statistic, it is an overall measure of error between a prediction (accounting earnings and rate of return) and the actual event (permanent earnings and rate of return). Theil suggests the U statistic can be decomposed into three "partial coefficients of inequality due to unequal central tendency (bias), to unequal variation

(variance), and to imperfect covariation (covariance proportions)."[44] Further study of the properties of the "U" statistic and an analysis of the "decomposed" U values are currently underway.

2) Inclusion of a General Price Level Factor--one of the limitations previously cited related to the use of "constant" dollars over time. A second extension will incorporate a price level factor and utilize still another accounting method--price level adjusted, historical cost financial statements. Similar comparisons (as in the current study) will then be made to evaluate the alternative accounting measurement schemes.

3) Ability of Alternative Accounting Methods to Indicate Managerial Ability- given the lack of agreement regarding a common "user" model and the ability of managers to manipulate income through smoothing techniques, one extension is to evaluate alternative earnings models on the basis of their ability to differentiate superior managerial ability. This proposed extension would simulate a "mini-economy" with at least two firms competing in the same markets. The firms would be allowed to vary in managerial ability with respect to optimum decision making. The operating results, as measured by alternative accounting methods, would then be compared to determine which method can discriminate the differing managerial abilities the quickest.

XI) Summary

In summarizing the results of this study, the following conclusions are limited to the results of the Phase II analyses. Further, for the sake of brevity, all conclusions drawn are on the basis of the error criterion--i.e., the "U" statistic.

1) Direct costing methods were found to outperform their absorption costing counterparts with respect to earnings though the results were reversed regarding rate of return.

2) Historical cost produced a smaller estimation error for both earnings and ROR than any alternative method.

3) Business profit outperformed current operating profit and both net realizable value methods in estimating earnings and ROR.

4) Current operating profit absorption produced less estimation error, with respect to earnings, than either net realizable value method.

5) Both net realizable value methods outperformed current operating profit absorption regarding ROR.

6) A series of transformation functions were found which converted "actual" accounting ROR's into a set of "predicted" ROR's--all of which were "closer" (i.e., less error) to the permanent ROR than the unadjusted figures.

FOOTNOTES

[1]For example, see: R. R. Sterling, ed. Asset Valuation and Income Determination, (Scholars Book Company: Lawrence, Kansas, 1971); and Norton M. Bedford and James C. McKeown, "Comparative Analysis of Net Realizable Value and Replacement Costing," The Accounting Review, (April, 1972), pp. 333-338.

[2]Objectives of Financial Statements - Volume I, (American Institute of Certified Public Accountants: New York, NY, 1973).

[3]This concept, as defined by Greenball in "The Concept, Relevance and Estimation of the Permanent Earnings of the Firm" (unpublished Ph.D. dissertation, University of Chicago, 1966), has been adopted in this study.

[4]James C. McKeown, "A Test of the Feasibility of Preparing Exit Value Accounting Statements" and Lawrence Revsine, "A Test of the Feasibility of Preparing Replacement Cost Accounting Statements;" both can be found in Objectives of Financial Statements - Volume II, (American Institute of Certified Public Accountants, New York, NY, 1974), pp. 213-228 and pp. 229-244.

[5]Melvin N. Greenball, "The Accuracy of Different Methods of Accounting for Earnings--A Simulation Approach," Journal of Accounting Research, (Spring, 1968), pp. 114-129; and "The Concept, Relevance and Estimation of the Permanent Earnings of the Firm," (unpublished Ph.D. dissertation, University of Chicago, 1966).

[6]Replacement cost was actually divided into two sub-sets. "Business Profit" which included holding gains or losses and "Current Operating Profit" which adjusted business profit to exclude such gains and losses.

[7]Melvin Greenball, "The Accuracy of Different Methods of Accounting for Earnings--A Simulation Approach," pp. 124-127.

[8]Raymond J. Chambers, Accounting, Evaluation and Economic Behavior, (Prentice-Hall, Inc.: Englewood Cliffs, NJ, 1966).

[9]In fact, statistically significant differences were discovered when comparing the results of Phase I versus Phase II for select paired comparisons. A complete description will be offered in a later section of this paper.

[10]A perfect estimate would occur when the predicted value of permanent income is estimated to be accounting income (however, measured) without transformation--e.g., $f(x) = x$.

[11]Chapter I and Chapter 2 reference to Theil explicitly states that he is looking for a perfect estimator.

[12]Greenball, op. cit., pp. 115-119.

[13]For a complete description of the model the reader is referred to Chapter 6, "The Model of Class B Firms," of Greenball's dissertation.

[14]In fact, each firm is made a decision each period as to expand, contract, liquidate or maintain constant production level. Hence, the term "permitted" suggests the capability of liquidation during any period. The actual decision is a result of a decision model used by all firms.

[15]As Greenball suggests (pp. 112-116), if the definition of owners is expanded to encompass bondholders, then D also includes (1) the cash interest payments and (2) the cash payments for bond retirement. Similarly, the flow E would consist of the gross cash proceeds from the primary issuance of bonds.

[16]This relationship assumes the firm can acquire sufficient capacity in a short time period to make up any deficiency--i.e., if $n_{t-1} < Z_t$ then the firm must purchase at least $Z_t - n_{t-1}$ units of capacity prior to production.

[17]See Greenball, "The Concept, Relevance and Estimation of the Permanent Earnings of the Firm," (unpublished Ph.D. dissertation, University of Chicago, 1966, pp. 68-75) for a complete description of the stochastic parameters.

[18]For those firms with no forecasting ability (FRST = 0) it utilizes the t-1 value for its expected time t value since it knows the mean change in these values is zero.

[19]The actual derivation follows from the usual definition of rate of return. That is, it requires ending book value to be equal to the accumulated sum of beginning book value and capital investment (or withdrawal) occurring at the midpoint of the period, where the rate of accumulation is one plus the rate of return. This is expressed symbolically, as follows:

$$K_{a,i}(a) = (K_{a-1,i}(a)) \cdot (\sqrt{(1 + r_{a,i})} - C(a) \cdot (1 + r_{a,i}))$$

where: $K_{a,i}(a)$ is the book value at the end of period a computed at time a

$K_{a-1,i}(a)$ is the book value at the beginning of period a computed at time a

$C(a)$ is the net cash flow during period a

$r_{a,i}$ is the rate of return for period a

[20]These streams would range from 1 to 59 period long. (Forced liquidation occurred at the end of the 60th decision period.)

[21]In a "real world" setting at any point in time an investor could use the net realizable value for a given firm to determine the permanent earnings to that point.

[22]Greenball, op. cit., p. 116.

[23]The rationale for five variables is inherent in the simulation model. That is, each firm is basically identical other than the randomly determined variables associated with each.

[24]The initial random number "seed" in this second run was the same number as would have been used for the 201st firm in Stage I.

[25]Depreciation rate and systematic rate of growth are known by the firm. The other parameters were estimated at their mean values observed in Stage I for the first five periods and by the formulas below from period six on:

a) CVAR (Standard Deviation of Relative Factor Price Change) - estimated as:

$$\widehat{CVAR} = \sqrt{\frac{\sum_{i=1}^{n-1} (U_{mi}-\bar{U})^2 \cdot (U_{fi}-\bar{U})^2 \cdot (U_{li}-\bar{U})^2}{3(n-1)-1}}$$

where: U = relative factor price changes for materials (m), plant (f), and labor (l).

$\bar{U}$ = mean of all relative factor price changes to that point in time.

The observer will only know the relative price changes through period n-1. (Recall that this estimator is used beginning in period six.)

b) ALCR (correlation between relative change in α and relative factor price changes) - estimated as:

$$\widehat{ALCR} = \sqrt{\frac{\sum_{i=1}^{n-1} [(U_{mi} + U_{fi} + U_{li})-(3\bar{U})][U_{\alpha}-\bar{U}_{\alpha}]}{(n-2)\,(\widehat{CVAR})\,(\hat{\sigma}_{\mu\alpha})}}$$

where: $\hat{\sigma}_{\mu\alpha}$ = estimate of standard deviation of relative changes in α.

c) FRST (foresight) - calculated from the estimate of the standard deviation of relative factor price changes ($\widehat{CVAR}$) and an estimate of the standard deviation of errors in estimates (computed in a similar manner.) Specifically,

$$\widehat{FRST} = \sqrt{1 - \frac{\hat{\sigma}_e^2}{\widehat{CVAR}^2}}$$

where: $\hat{\sigma}_e^2$ = estimate of error's variance

[26]As will be discussed later, such a situation was found. That is, in certain cases Phase I and Phase II results were indeed statistically different.

[27]Henri Theil, Economic Forecasts and Policy, 2nd ed., (North Holland Publishing Company: Amsterdam), 1961, pp. 31-32.

[28]The reader is referred to Theil (pp. 31-48) for the complete derivation of this coefficient.

[29]In fact, such results were actually found in initial runs of the simulation model.

[30]To reduce the impact of the outlying values, a somewhat arbitrary limitation of .5 was placed on the basic statistic ($|PB_{i,j,a} - PE_{i,j,a}| / PE_{i,j,a}$) utilized in each of the performance indices XI, XQ and XB. The rationale for such a limitation is that the unique definition of permanent earnings can (and does) create the situation where, for a given period, $PB_{i,j,a}$ and $P_{i,j,a}$ differ drastically. Hence, the .5 limit constrains the difference between accounting earnings and permanent earnings to be no more than 50% of that period's permanent earnings.

[31]For example, $XBI = \frac{1}{200} \sum_{j=1}^{200} XU_{i,j}$ and so on for all eight indices.

[32]These tests took the form of comparisons between values from Stage I versus Stage II--e.g., HA_I vs. HA_{II}, HD_I vs. HD_{II}, etc.

[33]Upon discovery of these discrepancies the simulation model was closely reviewed to assure Greenball's model had been faithfully replicated. The simulation process, decision model, stochastic features, and accounting methods were all determined to be in exact agreement with the description of each--as identified in Greenball's dissertation, "The Concept, Relevance and Estimation of the Permanent Earnings of the Firm."

[34]While Greenball's paper indicates "Unless otherwise stated, such a significance level (.01) will be understood to apply to all comparisons" (P. 126--footnote #11), reference to the values reported in his dissertation found the "XB" values were not significant even at the .05 level.

[35]Contradictory in the sense that for the XQ measure HCA outperformed CA yet the same measure found CD better than HD. Even though none of these differences were significant at any level his statement "C methods 5 and 6 narrowly outperformed the H methods" (p. 127) is apparently misleading based on his results.

[36]The following "t" values were calculated based on the findings in his dissertation: (a) HA vs. CA → t = 1.727 and (b) HD vs. CD → t = 1.852.

[37]The market differential is created by "friction" in the marketplace. That is, at the moment of acquisition purchase price differs from exit value and an adjustment is made to the basic NRV earnings to account for this "friction." (See Equation 8.)

[38]The "U" statistic considers the entire series rather than individual values within a series. As such, the isolated cases of very small permanent earnings are not given inordinate weight in the overall inequality statistic.

[39]As described earlier all further measures of error (both for earnings and ROR) will employ the "U" statistic.

[40]Rankings of income and rate of return were made on the basis of "U" statistics (lowest to highest) for each of the 200 firms.

[41]Since the results of Phase II (dual input price change simulations) were determined to have greater generalizability this comparison is restricted solely to Phase II's findings. However, similar analyses (ANOVA and "t" tests) were

applied to Stage I versus Stage II's results (both from Phase I). The conclusions drawn from these analyses completely support the findings (from Phase II) described in the body of the paper.

[42]For example, see Eugene M. Lerner and Alfred Rappaport, "Limit DCF in Capital Budgeting," Harvard Business Review, (September-October, 1968), pp. 133-139.

[43]The length of a decision period was not specified other than being equal (overall) to a single accounting period. A decision period could represent any reasonable length of time--i.e., a year, quarter, etc. The point being, that since up to sixty decision periods were employed the results truly represent a longitudinal study.

[44]Theil, op, cit., pp. 34-35.